ELECTROMAGNETIC SWITCH FOR STARTER

This is a Division of Application No. 10/103,730 filed March 25, 2002. The entire disclosure of the prior application is hereby incorporated by reference herein in its entirety.

CROSS REFERENCE TO RELATED APPLICATION

This application is based on Japanese Patent Applications No. 2001-109102 filed on April 6, 2001, and No. 2001-220299 filed on July 19, 2001, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to an electromagnetic switch used in a starter for starting an internal combustion engine.

BACKGROUND OF THE INVENTION

According to an electromagnetic switch in JP-U-63-50432, a sealing member 120 is compressively fitted in a recess 110 formed on the inner wall of a molded cover 100, as shown in FIG. 10. A lead wire 140 of a coil is pulled out of the molded cover 100 through a through hole 130 of the molded cover 100 and a through hole in the sealing member 120. An end of the lead wire 140 pulled out of the molded cover 100 is soldered with a terminal 150 fixed on the molded cover 100. The through hole 130 of the molded cover 100 is sealed with solder 160 in order to secure air-tightness of the molded cover 100. In this

electromagnetic switch, the lead wire 140 has to be manually pulled out of the molded cover 100 because the lead wire 140 does not have rigidity. Further, the air-tightness is influenced by a soldering quality.

Incidentally, in this kind of electromagnetic switch, a return spring is slidablly mounted on the outer periphery of a rod supporting a movable contact. However, the return spring is likely to be interfered around the rod when it is mounted onto the rod and when it slides on the rod.

SUMMARY OF THE INVENTION

The present invention is made in view of the above problems, and it is an object to provide an electromagnetic switch for a starter, which is capable of being automatically assembled.

It is another object to provide an electromagnetic switch for a starter, which is capable of being automatically assembled and providing air-tightness.

It is further another object to provide an electromagnetic switch for a starter in which a return spring is properly mounted without being interfered.

It is still another object to improve mountability and slidability of the return spring.

According to an aspect of the present invention, in an electromagnetic switch for a starter, a plate-like terminal having rigidity is press-fitted in a bobbin in an axial direction, and an end of an excitation coil wound around the

bobbin is connected to the terminal. A cover is mounted such that the terminal passes through the cover.

In this structure, the terminal connected to the excitation coil extends out the molded cover, instead of pulling the excitation coil without having rigidity out of the molded cover. Therefore, steps up to fixing the molded cover can be automatically operated in an assembly process.

According to another aspect of the present invention, a rod supporting a movable contact at an end is movable with a plunger through a return spring in an axial direction. The rod has an annular groove on its outer circumferential surface and a rod cover is fitted on the rod. The rod cover has a flange, a cylindrical part and a distal end opposite to the flange. The cylindrical part has a plurality of projections which project inwardly from the inner circumferential surface of the cylindrical part to be fitted in the annular groove. The plurality of projections is arranged in the circumferential direction. The cylindrical part defines a plurality of slits that extend in the axial direction between the adjacent projections and is closed before the distal end.

In this structure, the cylindrical part other than the distal end of the rod cover can expands radially outward while the plurality of projections is passing on the outer periphery of the rod and before it is fitted in the annular groove when the rod cover is mounted onto the rod. Therefore, the rod cover is properly mounted onto the rod. In addition, since plurality of slits is closed before the distal end and the

distal end has an annular shape, the distal end of the cylindrical part is restricted from expanding radially outward so that the cylindrical part remains its original shape after the rod cover is fitted on the rod. The return spring is mounted onto the rod cover by being guided by the outer circumferential surface of the cylindrical part from its distal end side, as a guide surface. Therefore, it is restricted that the return spring is caught in the plurality of slits of the rod cover. Accordingly, the return spring is properly mounted onto and slidable on the rod cover.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features and advantages of an embodiment will become more apparent from the following detailed description made with reference to the accompanying drawings, in which:

FIG. 1 is a cross-sectional view of an electromagnetic switch taken along in an axial direction, according to a first embodiment of the present invention;

FIG. 2A is a side view of a coil wound around a bobbin of the electromagnetic switch including a partial cross-section;

FIG. 2B is an axial end view of the bobbin;

FIG. 3A is a side view of a switch case and a terminal including a partial cross-section;

FIG. 3B is an axial end view of the switch case;

FIG. 4A is a side view of a first terminal press-fitted

in the bobbin;

FIG. 4B is a side view of a second terminal press-fitted in the bobbin;

FIG. 5 is an axial end view of a terminal holder provided on a flange of the bobbin;

FIG. 6 is a side view of the first terminal;

FIG. 7 is a perspective view of the terminal holder and a sealing member press-fitted on the first terminal;

FIG. 8A is an end view of the sealing member;

FIG. 8B is a cross-sectional view of the sealing member;

FIG. 8C is a side view of the sealing member;

FIG. 9 is a partial cross-sectional view of the second terminal penetrated through a molded cover;

FIG. 10 is a partial cross-sectional view of a lead wire pulled out a molded cover of a prior art;

FIG. 11A is a side view of a subunit including a movable contact;

FIG. 11B is an end view of the subunit in FIG. 11A;

FIG. 12A is a cross-sectional view of a rod cover taken along in an axial direction;

FIG. 12B is a cross-sectional view of the rod cover taken along line XIIB-XIIB;

FIG. 13 is a side view of a subunit including a movable contact according to a second embodiment of the present invention;

FIG. 14A is a side view of a subunit including a movable contact as a comparative embodiment; and

FIG. 14B is an end view of the subunit in FIG. 14A.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Embodiments of the present invention are described hereinafter with reference to drawings.

An electromagnetic switch 1 of the embodiment turns on/off a main contact (described later) provided on a motor electric circuit of a starter (not shown). As shown in FIG. 1, the electromagnetic switch 1 has excitation coils 2 and 3, a plunger 4 and the like. When electric current is supplied to the excitation coils 2 and 3, the excitation coils 2 and 3 generate magnetic force. With this magnetic force, the plunger 4 moves in an axial direction of the excitation coils (right/left direction in FIG. 1).

The main contact has a pair of fixed contacts 7 and 8 and a movable contact 9. The movable contact 9 is movable with the plunger 4a. The fixed contacts 7 and 8 are respectively provided on heads of two terminal bolts called a battery terminal 5 and a motor terminal 6, inside a molded cover 10. The battery terminal 5 and the motor terminal 6 pass through the molded cover 10 and are fixed with washers 11 and 12 outside of the molded cover 10. The battery terminal 5 is connected with a cable (not shown) from a battery and the motor terminal 6 is connected with a lead wire (not shown) that supplies power to the starter.

The excitation coils 2 and 3 are wound around a bobbin 13 in a double-layered manner. The excitation coil 2 is an

attracting coil that mainly generates magnetomotive force for pulling the plunger 4. The excitation coil 3 is a holding coil that mainly generates magnetomotive force for holding the plunger 4 after the main contact closes. A terminal 14 (described later) is attached to the bobbin 13, as shown in FIG. 2A. A lead wire 2a of the attracting coil 2 and a lead wire 3a of the holding coil 3 are connected to the terminal 14. A cylindrical sleeve 15 is provided on the inner periphery of the bobbin 13 to guide the plunger 4, so the plunger 4 is slidable in the bobbin 13 in the axial direction. In the cylindrical sleeve 15, a stator core 16 is arranged opposite to the plunger 4 in the axial direction, and a return spring 17 is provided between the plunger 4 and the stator core 16. The plunger 4 is biased to a left side in FIG. 1 by the return spring 17.

The stator core 16 provides a magnetic circuit for guiding magnetic flux, with a yoke 18, a ground plate 19, a magnetic plate 20 and the like. These components are housed in a switch case 21, as shown in FIGS. 1 and 3A. The yoke 18 surrounds the excitation coils 2 and 3. The ground plate 19 and the magnetic plate 20 are respectively arranged adjacent to flanges 13a and 13b of the bobbin 13.

The molded cover 10 is assembled in the axial direction (from a right side in FIG. 1) against the ground plate 19 and a packing 22 is sandwiched between the ground plate 19 and the molded cover 10. An end of the switch case 21 is deformed inwardly to fix the molded cover 10.

Next, detailed structures of the terminal 14 and the bobbin 13 are described.

The terminal 14 includes a first terminal 14A and a second terminal 14B. The flange 13a of the bobbin 13 has two terminal holders 23 for fixing the terminals 14A and 14B, as shown in FIGS. 2A, and 2B. The terminal holders 23 protrude from the flange 13a in the axial direction, and are arranged to oppose to each other in a radial direction of the flange 13a. In a state that the bobbin 13 is disposed in the switch case 21, the terminal holders 23 project from an open end of the switch case 21 in the axial direction.

Each of the terminal holders 23 provides a slot 23a on its axial end surface to receive an end of the terminal 14, as shown in FIG. 5. The terminal holder 23 provides longitudinal wall portions 23b to restrict the terminal 14 from moving in its thickness direction. The longitudinal wall portions 23b protrude in the axial direction on both sides of the slot 23a. Further, the terminal holder 23 has lead wire holding slits 23c on its side surface, so the lead wires 2a and 3a are pulled out the bobbin 13 and held in the slits 23c. An inner side wall 23e defining the slit 23c inwardly protrudes such that a width of an opening 23d of the slit 23c is slightly narrower than a diameter of the lead wires 2a and 3a. Thus, the lead wires 2a and 3a are not easily removed from the slits 23c.

The first terminal 14A is connected with a lead wire (not shown) connected to the starter switch. The second

terminal 14B is connected to the motor terminal 6 through a conducting plate 24, as shown in FIG. 9. The first and the second terminals 14A and 14B are press-fitted in the slots 23a of the terminal holders 23, as shown in FIGS. 4A and 4B

Each of the terminals 14A and 14B has a plate-like shape having a predetermined length, as shown in FIG. 6. Here, a bottom end (bottom side in FIG. 6) of the terminal 14, which is press-fitted in the slot 23a is referred to as a first end 14e and a top end of the same is referred to a second end 14f. The first end 14e has serrated portions 14c on its longitudinal side edges or on its outer periphery, so the terminal 14 is firmly fitted in the slot 23a.

The terminal 14 has at least one arm portion 14d on its longitudinal edge above the serrated portion 14c to fasten the lead wires 2a and 3a. The arm portion 14d is made by folding an extended portion of the terminal 14 so as to hold the lead wires 2a and 3a, as shown in FIG. 7. The first terminal 14A has two arm portions 14d, as shown in FIG. 4A. The second terminal 14B has one arm portion 14d, as shown in FIG. 4B.

The lead wires 2a and 3a are connected to the terminal 14 in the following manner. As shown in FIGS. 4A to 5, the lead wires 2a and 3a are pulled out the bobbin 13 and held in the lead wire holding slits 23c. Then, each end of the lead wires 2a and 3a is fastened in the arm portion 14d, and connected to the terminal 14 by welding or the like. More specifically, in the first terminal 14A, the lead wires 2a and 3a are fastened and connected to the arm portions 14d, as

shown in FIG. 4A. In the second terminal 14B, only the lead wire 2a is fastened and connected to the arm portion 14d, as shown in FIG. 4B, and the remaining end of the lead wire 3a is held in the lead wire holding slit 23c and fixed on the surface of the ground plate 19 by welding or the like.

A sealing structure of the molded cover 10 is described hereinafter. The molded cover 10 has a through hole 10b allowing the terminal 14 to pass through. As shown in FIG. 9, the terminal 14 passes through and the second end of the terminal 14 extends out of the molded cover 10. A sealing member 25 is press-fitted to each terminal 14 to air-tightly seal a clearance between the molded cover 10 and the terminal 14. The sealing member 25 is, for example, made of rubber. The sealing member 25 is a ring-shaped having a through hole 25a in the middle, and has projections on its outer peripheral surface, as shown in FIGS. 8A to 8C.

The terminal 14 is inserted into the through hole 25a so that the sealing member 25 is tightly fitted on the outer periphery of the terminal 14, as shown in FIG. 3A. When the molded cover 10 is mounted, the sealing member 25 is disposed and pressed in the recess 10a provided inside the molded cover 10, as shown in FIG. 9. The projections of the outer peripheral surface of the sealing member 25 tightly contact the inner peripheral surface of the recess 10a. Accordingly, the clearance between the terminal 14 and the molded cover 10 is air-tightly sealed.

Next, detailed structures around the plunger 4 and the

return spring 17 relating to the movable contact 9 are described hereinafter.

The movable contact 9 is supported on an insulator 38 (e.g. Bakelite) provided on the rod 36 in a slidable manner, as shown in FIGS. 11A and 11B. This movable contact 9 is assembled into a subunit 90 with a rod cover 40 and a contact spring 42. The rod 36 passes through the center of the stator core 16 and is slidable in the axial direction. The rod 36 is biased toward the plunger 4 (left side in FIG. 1) by a spring 44 provided between the rod 36 and the molded cover 10. While the plunger 4 is being attracted by the magnetomotive force generated in the attracting coil 2, the rod 36 is moved to the right side (in FIG.1) with the plunger 4, and the spring 44 is compressed with the rod 36. When the magnetomotive force extinguishes, the rod 36 is sprung back to a stationary position shown in FIG. 1 by reactive force of the spring 44.

The rod cover 40 is fitted on the outer circumferential surface of the rod 36, as shown in FIGS. 11A and 11B. The rod cover 40 is, for example, made of resin. A contact spring 42 is provided between a flange 40a of the rod cover 40 and the insulator 38. The contact spring 42 applies contact pressure to the movable contact 9 after the rod 36 moves with the plunger 4 and the movable contact 9 contacts the fixed contacts 7 and 8. Specifically, the rod cover 40 has a cylindrical part 40s and the flange 40a, as shown in FIGS. 12A and 12B. A plurality of projections 40b is provided to inwardly project from the inner circumferential surface of the

cylindrical part 40s and arranged in a circumferential direction. The projections 40b fit in an annular groove 36a provided on the outer circumferential surface of the rod 36, so the rod cover 40 is restricted from moving in the axial direction with respect to the rod 36.

Slits 40c are provided on the cylindrical part 40s, as shown in FIGS 12A and 12B. Each of the slits 40c is provided between adjacent projections 40b arranged in the circumferential direction, and extends in the axial direction. The slit 40c penetrates the cylindrical part 40s from the outer circumferential surface to the inner circumferential surface. The cylindrical part 40s includes an annular-shaped connecting portion 40d at its distal end (left side end in FIG. 12A), so the slits 40c are closed at the connecting portion 40d. The outer circumferential surface of the connecting portion 40d is tapered off to its distal end. That is, the outer diameter of the connecting portion 40d is decreased toward its distal end, to easily mount the return spring 17 onto the cylindrical part 40s.

The inner diameter of the return spring 17 is slightly larger than the outer diameter of the rod cover 40. The return spring 17 is mounted onto the rod cover 40 in the axial direction (from the left side in FIG. 12A). At this time, the outer circumferential surface of the cylindrical part 40s including the outer circumferential surface of the connecting portion 40d functions as a guide surface.

According to the above-described electromagnetic switch

1, the lead wires 2a and 3a are connected to the terminal 14 having rigidity. The terminal 14 passes through the molded cover 10 from an inside to an outside. That is, when the molded cover 10 is assembled, the second end 14f of the rigid terminal 14 can be extended out of the molded cover 10, instead of pulling the lead wires 2a and 3a that do not have rigidity out of the molded cover 10. Therefore, steps up to fixing the molded cover 10 can be automatically operated in an assembly process.

The bobbin 13 has the terminal holders 23 defining the slots 23a for receiving the terminals 14 A and 14B and the terminal holders 23 extend from the flange 13a in the axial direction of the bobbin 13. In this case, components such as the ground plate 19, packing 22, sealing member 25, and molded cover 10 are assembled in a longitudinal direction of the terminal 14, that is, the axial direction of the bobbin 13. Therefore, these components can be automatically assembled.

Further, each of the terminal holders 23 has the longitudinal wall portions 23b on both sides of the slot 23a. Therefore, the terminal 14 is restricted from moving in its thickness direction during the assembly. Accordingly, components such as the sealing member 25 and the molded cover 10 mounted in relative to the terminal 14 are easily assembled.

In addition, the terminal holder 23 has the lead wire holding slits 23c. Therefore, in the state that the lead wires 2a and 3a pulled out the bobbin 13 are held in the lead wire holding slits 23c, the ends of the lead wires 2a and 3a are

fastened in the arm portions 14d of the terminal 14 and welded to the terminal 14. Accordingly, the lead wires 2a and 3a are easily handled and securely connected to the terminal 14 in a right position. As a result, poor connection of the lead wires 2a and 3a to the terminal 14 is reduced. In addition, the lead wires 2a and 3a do not disturb assembly of the ground plate 19. Therefore, the ground plate 19 can be assembled automatically.

In the electromagnetic switch 1, the ring-shaped sealing member 25 press-fitted to the terminal is used as the sealing structure of the molded cover 10. In this case, the sealing member 25 is securely fitted to the terminal 14. Therefore, the sealing member 25 is restricted from being moved when the molded cover 10 is assembled, thereby ensuring the sealing structure. Also, it is possible to automatically assemble the molded cover 10.

Furthermore, the longitudinal wall portions 23b are spaced apart equal to or slightly wider than the thickness of the terminal 14. Therefore, the movement of the terminal 14 in the thickness direction may be effectively decreased. Also, it is not always necessary to provide the two longitudinal wall portions 23b. For example, the terminal holder 23 may have at least one longitudinal wall portion, in order to restrict the terminal 14 from moving in the thickness direction during assembly. Also, the wall portion 23b may have any other shapes.

Since the terminal 14B does not have a second arm portion to fasten the lead wire 3a, the longitudinal wall portions 23b of the terminal holder 23 for the terminal 14B

may be larger or wider than those for the terminal 14A, for example. Alternatively, it is possible to provide a single longitudinal wall portion having a different shape such that the longitudinal wall portion protrudes in the axial direction to surround the terminal 14B. According to these arrangements, it is effective not only to fix the terminal 14B steady to the terminal holder 23, but also to restrict the lead wire 3a connected to the ground plate 29 from short-circuiting by terminal 14B.

In the electromagnetic switch 1, the rod cover 40 has the plurality of slits 40c on the cylindrical part 40s in the axial direction. Therefore, when the projections 40b of the cylindrical part 40s are passing or moving on the outer periphery of the rod 36 in the axial direction while the rod cover 40 is mounted onto the rod 36, the cylindrical part 40s can expand radially outward. Accordingly, force required to press the rod cover 40 in the axial direction until the projections 40b fit in the annular groove 36a of the rod 36 can be reduced. In this way, the rod cover 40 is easily mounted onto the rod 36.

Further, since the slits 40c are closed at the connecting portion 40d, the return spring 17 is more successfully mounted to onto the rod cover 40, as compared with a rod cover 40e shown in FIGS. 14A and 14B. In the rod cover 40e, for example, slits 40f are not closed at the distal end of the rod cover 40e and the cylindrical part 40t is separated into a plurality of resilient pieces. In the rod

cover 40, however, since the slits 40c are closed at the connecting portion 40d, it is restricted that the return spring 17 is caught by the cylindrical part 40s of the rod cover, when it is mounted onto and slides on the rod cover 40.

Further, since the slits 40c are closed by the connecting portion 40d, the cylindrical part 40s of the rod cover 40 is restricted from excessively expanding radially outward when the rod cover 40 is mounted onto the rod 36. That is, the rod cover 40 is not deformed beyond its resilient range, but remains its original shape after the projections 40b fit in the annular groove 36a. Therefore, it is decreased that the return spring 17 presses the outer circumferential surface of the cylindrical part 40s. Accordingly, the return spring 17 is properly mounted onto the rod cover 40 and can slide on the rod cover 40 in the axial direction without being caught by the cylindrical part 40s or in the slits 40c.

(Second embodiment)

An axial length of the rod cover 40 may be increased as compared with that of the first embodiment. Preferably, an axial length L1 of the rod cover 40 from the distal end to the projections 40b is substantially equal to an axial length L2 of the rod 36 from a distal end to the annular groove 36a thereof, as shown in FIG. 13.

With this arrangement, an axial length of the slits 40c can be increased in the axial direction as compared with that of the first embodiment. Therefore, the cylindrical part 40s of the rod cover 40 can easily expand radially outward when it

is mounted onto the rod 36. Accordingly, the pressing force required to mount the rod cover 40 onto the rod 36 can be decreased. Since the axial length of the slits 40c is increased, the cylindrical part 40s becomes flexible more than that of the first embodiment. Therefore, the deformation of the cylindrical part 40s can be decreased, and the return spring 17 is properly mounted onto the rod cover 40.

The present invention should not be limited to the disclosed embodiments, but may be implemented in other ways without departing from the spirit of the invention.